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CAN MARKET ECONOMY BE ECOLOGY-FRIENDLY ?

THE CASE OF WASTE RECYCLING IN THE NINETEENTH CENTURY

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Abstract : *Sustainable development theorists frequently stress various ways by which market economies could be reformed in order to preserve the natural environment. Regulatory interventionism or ethical activism are frequently stressed a normative way in order to fulfil such an institutional task. European industrial history, however, suggests that the creation of valuable by-products from polluting industrial waste and emissions was "business as usual", resting on economic behaviors brought about a free market economy. This case suggests that market incentives might have been more compatible with "environmental responsibility" than is usually believed.*

Keywords : sustainable development, waste recycling, market economy,

Since the publication of the Brundtland Report in 1987 (*Our common future,* United Nations), sustainable development (henceforth, SD) has become a top priority in the public policy agenda of most developed countries as well as a relentless issue in the public debate and academic literature, foremost in economics and management sciences.

Among the various concerns raised by the SD literature, the question of the institutional means enabling market economies –*i.e* companies- to take a better care of their natural environment is high on the list of issues. Indeed, numerous papers contend that pollution prevention measures systematically increase production costs, thereby inducing corporate managers to invest as little as possible effort in that respect. Once widely assumed that "business as usual" –and thereby "unregulated" market economies- spontaneously tend to be ecology-unfriendly, concepts and devices aiming at correcting this alleged market failure unfold. In the last decades, in addition to growing advocacy for taxation and regulation, « business ethics», « Corporate Social Responsibility » (henceforth, CSR), « best practices of governance» and « stakeholder theory » have all flourished as scientific concepts aiming at making business greener than it is by its own constitution.

However, do companies really need to be equipped with such a conceptual prosthesis, either regulatory or ethical in order to curb their alleged proclivity to wreck the natural environment ? One approach to addressing this question is to look at the impact of market incentives on industrial behavior in societies characterised by generally free-market policies, but where governmental regulations and general interest in protecting the

environment are significantly weaker than in currently developed economies. Focusing on the case of waste recycling in industries operating in nineteenth century's Western economies, this essay will challenge the mainstream view assuming that market-oriented activities are spontaneously harmful to their environment unless disciplined by extra-economic devices. Therefore, in the following, we will assume (1) waste recycling to be a case of sustainable economic practice and (2) European nineteenth century to be an archetypical age of laissez faire policies, especially in Victorian England (see Paul 1980). Although our line of argument is supportive rather than conclusive –mostly based on case study bibliographic materials- it brings about insights challenging the mainstream premises of SD theories.

This paper is structured as follows : the first section will briefly delineate the main arguments put forward by sustainable development and environmental economics in order to support that free markets lead on externalizing costs of waste disposal unless politically (or ethically) oriented another way. The second section will challenge such a belief by introducing the main insights drawn from writings dedicated to the waste recycling/by products development in the industry of the 19th century ; we will see that numerous authors emphasized that waste reuse was business as usual by that time, somehow anticipating by almost a century and a half some of the most hotly contested debates and concepts in the current literature on SD. The third section will deal with motives and institutions which arguably triggered the propensity of nineteenth century entrepreneurs to take the best advantage from their residuals ; some counterintuitive avenues of research will finally be sketched in line with such insights.

1. The commonplace premise : markets must be "civilized" by ethics and politics.

« There will be no sustainable economic development as long as it is not embedded in a superordinate societal context – and it is a *cultural and political* task to ensure this embedding » (Ulrich, 2010 : 100). Whilst one can never derive a "hard" general statement from a single quotation, the latter looks to be representative of a widespread belief regarding the way SD and markets do interplay. The "cultural" task invoked by this quotation echoes the normative ambition of much SD, CSR and stakeholder theory literature (see Donaldson and Preston, 1995) while the call for "political task" likely pertains to taxation and regulation.

In order to be comprehensive, the way that SD literature envisions the degree of harmony between "natural environment" and "markets" would call for a specific "exegetic" research. There is certainly not "one view" about that issue and it would be dishonest to deny the controversies it brings about. For instance, Vanberg (2007) identifies three versions of CSR-demands: (i) "soft" (concerned with how socially responsible corporations ought to play the market game within existing rules); (ii) "hard" (concerned with how the rules of the market ought to be changed in order to induce "socially responsible" corporate behavior; and (iii) "radical" (which rejects the compatibility of CSR and market incentives and calls for the adoption of some alternative economic regime). Common to all three, however, is a lack of faith in the capacity of free markets to generate wealth equitably and sustainably.

Moving from CSR/SD literature to environmental economics does usually not change the overall picture. Although environmental economics is grounded in neoclassical welfare economics, looking less subject to ideological prejudices than SD literature may sometimes be, it usually contends that the search for increased profitability results in unmanageable pollution problems, the depletion of nonrenewable resources, habitat and species destruction, and a regulatory "race to the bottom" among competing jurisdictions (Hay et al., 2005). In the same vein, the leading environmental economist Robert Stavins argues that "if the market is left to itself, too many pollution-generating products get produced" (2004 : 12), a point summed up in the following way by economists Marie-Francois Calmette and Isabelle Péchoux : "it is well known that polluting agents need to be induced to internalize the social cost of pollution damage, otherwise they will engage in excessive levels of emission of pollutants" (2006: 184). Management professors Roland Geyer and Tim Jackson further argue that traditional supply chains are based "on a linear production paradigm which relies on constant input of virgin natural resources and unlimited environmental capacity for assimilation of wastes and emissions" ; in their opinion, "there is general agreement that this is causing environmental costs on a large scale and of a systematic nature, which cannot be fully addressed by traditional supply chain management » (2004 : 56).

Such views are readily turned into assumptions made about the propensity of "business as usual" to externalize costs related to their waste's disposal : for instance, Jaffe et al. suggest that innovations such as cleaner production methods, new pollution control equipment or new substitutes for environmentally harmful products alter the "terms of the tradeoff between the marginal cost of pollution control and its marginal social benefit". When this is the case, a "specified level of environmental cleanup can be achieved at a lower total cost to society" while "a lower total level of pollution can be attained more efficiently" (2005 : 166). While Turner acknowledges the existence of opportunities for firms to develop innovations that are both profitable and environmentally beneficial, he argues : "fundamental waste reduction measures will often prove to be financially unprofitable" (2000 : 716). Indeed, this author stated in an earlier book that the "basic difference between natural and economic systems (…) is that natural systems tend to recycle their waste [while] economies have no such built-in tendency to recycle" (Pearce and Turner 1990 : 36). This latter perspective is shared by Ayres who postulates : "the industrial system is very wasteful of materials and recycles very little" (2004 : 427).

In short, many environmental economists currently view industrial waste and its resulting pollution as a market failure to be handled through government intervention, rather than a market opportunity for polluting businesses to develop profitable technologies that have both financial and environmental benefits. As Fullerton and Stavins put it, many economists like themselves "make a living out of analyzing market failures such as environmental pollution in which laissez-faire policy leads not to social efficiency, but to inefficiency" (1998 : 433). Turner similarly concludes that "unfettered markets fail to allocate environmental resources efficiently" (2000 : 705). In a more detailed conceptual analysis where they state that a typical firm "does not have an economic incentive to minimize the 'external' costs of pollution" (p. 165), Jaffe et al. (2005) write that "pollution creates a negative externality, and so the invisible hand allows too much of it"

(p. 166) and go so far as to argue that technical change relative to the environment occurs at the nexus of two distinct and important market failures :

"Pollution represents a negative externality, and new technology generates positive externalities. Hence, in the absence of public policy, new technology for pollution reduction is, from an analytical perspective, doubly underprovided by markets. This suggests that the efficiency of environmental policy depends on its consequences for technological change, and also that there is a potential role for policy aimed directly at the stimulation of environmentally beneficial technological change" (Jaffe et al., 2005 : 168).

The conceptual framework of mainstream environmental (and SD) economics lies in the notion of "externality" (see Pigou, 1932) according to which costs of "collateral damage" caused by productive activities, while not being incurred by firms, are not reflected in market prices ; henceforth, since the latter fail to reach their optimal level, public intervention is required in order to help out prices to comply with their first best value. As we will see in part three, such a vision of "what a market is about" should not remain unchallenged. At this stage of the argument, one may admit that, stated in a nutshell, the mainstream vision of the interplay between natural environment and the market economy refers to the following theoretical storyboard :

(i) Business spontaneously tends to externalize environmental costs. Focusing on wastes, the natural propensity of firms would be to dump them into rivers, the atmosphere or the underground at the lesser cost.
(ii) It is not to say that market-based policies (for instance cap and trade policies) or incentives may not result in efficient ecological outcomes. Be it a better use of raw materials (see Boiral, 2005) or a green-oriented business strategy bringing win-win benefits (Lanoie et Tanguay, 1999), the institutions of capitalism may prove making economy and ecology compatible.
(iii) But whether markets can lead on ecology-friendly behaviours depends on an "extra economic" impetus –"a superordinate societal context"- of a regulatory (see the famous "Porter hypothesis", Porter, 1991[1]) or an ethical nature.

Interestingly, various "Victorian (and European) pioneers of corporate sustainability" (Desrochers, 2009a) have emphasized the propensity of industrials to "close the loop" of their residuals throughout the 19th century without any "social responsibility" awareness or "command and control" regulation to figure predominantly in the process. The following section introduces the main statements and insights drawn from ancient books having paid attention to this issue.

[1] The Porter Hypothesis suggests that 'well-designed' and 'well-enforced' environmental regulations will encourage firms to reduce waste, increase efficiency, and utilize newer and more efficient production technologies. Through incentives that otherwise don't exist in a market economy, managers and engineers will be compelled to examine their operations more closely, discover inefficiencies in and eventually improve upon production activities. As a result, they will more than fully offset compliance costs, become more competitive and profitable than non-regulated rivals, and reduce their environmental impact.

2. "Loop closing" and "industrial symbiosis" as "business as usual" practices in the 19th century :

2-1. Recycling waste in the 19th century : a well-documented pattern

Table 1 here below lists the authors and books having the most fully documented the propensity of 19th century European (and American) industrials to create valuable by-products from polluting industrial wastes and emissions.

Table1 : authors and books having dealt with waste recycling in the 19th and early 20th centuries

Author (Nationality)	**Title of their main work**	**Year of publication**	**Editor (number of pages)**
Babbage, Charles (USA)	*On the Economy of Machinery and Manufacture*	1832	
Playfair, Lyon (UK)	*On the Chemical Principles Involved in the Manufactures of the Exhibition as Indicating the Necessity of Industrial Instruction*	1852	Society for The Encouragement of Arts, Manufactures and Commerce, London,
Simmonds, Peter Lund (UK)	*Waste Products and Undeveloped Substances: A Synopsis of Progress Made in Their Economic Utilisation During the Last Quarter of a Century at Home and Abroad.*	1876; 1873; 1862	Hardwicke and Bogue ; 491p.
De Freycinet, Charles (France)	*Traité d'assainissement industriel, comprenant la description des principaux procédés employés dans les centres manufacturiers de l'Europe occidentale pour protéger la santé publique et l'agriculture contre les effets des travaux industriels*	1870	Dunod (Paris)
Koller, Theodor (Germany)	*The Utilization of Waste Products. A Treatise on the Rational Utilization, Recovery, and Treatment of Waste Products of All Kinds*	1918 ; 1915 ; 1902 (German editions : 1921; 1902; 1880)	Scott, Greenwood & Sons (London); D. Van Nostrand (New York) ; 338p.
Frederick A. Talbot (USA)	*Millions from Waste*	1920	J. B. Lippincott Company, Philadelphia
Clemen, Rudolf (USA)	*By-products in the packing industry*	1927	University of Chicago Press

			(Chicago)
Razous, Paul (France)	*Les déchets et sous-produits industriels. Récupération, Utilisation.*	1937; 1921; 1905	Dunod (Paris) ; 604p.
Kershaw, John B. C. (UK)	*The Recovery and Use of Industrial and Other Waste*	1928	Ernest Benn Limited ; 212p.
Lipsett, Charles (USA)	*Industrial Wastes and Salvage : Conservation and Utilization*	1963 ; 1951	Atlas Publishing, Company; 406p.

Table 1 is far from being comprehensive : in the wake of some "pioneers" such as Peter Lund Simmonds, many authors took an interest in the topic of waste recycling from the mid-19th century to the early 20th century so that references dedicated to this matter (and authors having scrutinized it) abound ; however, authors and volumes reported in table 1 prove to have been influential and make up a substantial part of the documentation available ; they provide together several thousands of cases pertaining to the major sectors featuring the industrial revolution. Some of the most outstanding cases reported in this ancient literature deserve to be introduced in order to exemplify the full trend at work by this time :

Cattle horn

Cattle horn is the most striking example introduced in Charles Babbage's work. From such an unexpected raw material have been derived by-products as numerous as combs, toys, substitutes for glass, knife handles, tops of whips and even compounds of soap[2].

Madder plant and other residuals used by the chemical industry

As a chemist, Playfair focused mostly on advances in chemical knowledge which had resulted in the development of "methods of utilizing products apparently worthless, or of endowing bodies with properties which render them of increased value to industry". Among other cases, Playfait stressed that one major problem facing the chemical industry was the root leftovers of the madder plant from which coloring had been extracted. This residual matter was not valuable enough to be sold as manure and was therefore typically disposed of in rivers, where it caused considerable damage. In time, however, a simple treatment with a hot acid was devised that recovered profitably the one-third of the coloring matter lost in the process. Solid paraffin, fruit liquors or ink are other outstanding cases of outputs derived from waste utilizing documented by Playfair.

Coal tar

Playfair also dwelt on the case of "coal tar" –a residual from coal gasification- along with some other authors (see Desrochers, 2009b). Coal tar was one of the most repulsive

[2] Less central for our argument, Babbage also observed how advances in mechanical precision and mass production resulted in "a degree of economy in the consumption of the raw material which is, in some cases, of great importance ». (1832 : 62-63).

nuisances known to the manufacturers, killing all aquatic life when discharged in rivers, destroying the surrounding vegetation when buried and poisoning the atmosphere when burned ; therefore, its elimination commanded "the expenditure of enormous sums of money and prodigious thought" (Talbot, 1920 : 15). However, a gradual process led on turning it into one of the most valuable by-products ever developed, in such an extent that its use caused filled with wonder comments (see Desrochers, 2009b : 6). The first highly significant demand for coal tar followed the introduction of the wood pressure-impregnation process in 1838 (also known as the Bethell). This 'pickling' or 'creosoting' of timber – a process through which dried timber was placed in a container, subjected to partial vacuum and impregnated with heavy oils from coal tar – soon thrived on a large scale as a result of the increasing demand for wooden sleepers by the railroad industry, of wooden poles by the telegraph industry and of various coastal structures which incorporated a significant amount of timber. Creosote generated so much productivity gains relating to the treatment of wood that against all odd, this coal tar by-product became an important British export item, especially for the burgeoning American railroad industry.

Nevertheless, some remaining lighter fractions of tar oil did not find of outlet until advances in chemical industry do a raw material for the synthetic dyes industry. In time, advances in synthetic dye making served as a technological springboard for the creation of other tar-derived products ranging from explosives, medicines and perfumes, to flavouring materials, sweeteners, disinfectants and antitoxins, as well as tracing and photographic agents.

Iron slag

Even more unpromising than coal tar, slag from blast furnaces employed in the smelting of iron has long been the "nightmare" of furnace proprietors. Simmonds reports the enormous quantity of slag annually produced and how costly was its elimination as a nuisance. After many unfruitful attempts to develop it, some entrepreneurs/inventors achieved significant success in this respect providing it an outlet in mostly glass and cement industries (see Desrochers, 2009b : 11).

Livestock wastes

Clemen stresses various examples of outputs (food, pharmaceuticals, explosives, cosmetics and so on) derived from livestock wastes such as wasted blood, feet, heads and other non-edible animal parts. In the same vein, Simmonds observed that the stench resulting from the blood and offal at large pork-packing establishment "had become such an offense to the neighborhood, that the proprietors were threatened with a perpetual injunction" (1876: 39–40). The latter soon developed a method through which they dried the entire refuse, including the blood. The parts containing sufficient fat to make the operation economical were first treated in a rendering tank where the clean fat was converted into lard and the refuse into grease and grease oil. The scrap left in the process, consisting of the bones of the head and feet and considerable meat, was then thoroughly mixed with the blood, dried and converted into "a valuable article of commerce".

Among the authors listed in table 1, one special word must be said about Peter Lund Simmonds. The latter was the author with perhaps the broadest outlook on by-product development in the second half of 19th century. The first edition of his major book (*Waste Products*, see above, 1862) stresses that by-product development was a common practice in Victorian British industries, especially the most important ones including iron, wool, silk, cotton and leather. Nevertheless, his book's first edition is mostly dedicated to organic substances, the topic being "too extensive in its scope to be discussed successfully in detail" in his 35 chapters (*Waste Products*, 1862, v.) ; later editions would spread the coverage of the topic[3] and Simmonds undoubtedly became one of the leading advocates of waste recycling in the 19th century, his contributions –through publications and exhibits- having aroused much interest for this topic in the late 19th-early 20th centuries.

Some highlights must be drawn from this literature :

At first and not losing sight that generalisations derived from case studies are always problematic, all the authors reported in table 1 stress the "business as usual" side of by-product development "since every day furnishes new instances of what has become one of the most striking features of modern industry –to let nothing be lost, and to re-work with profit and advantage the residues of former manufactures" (Simmonds, 1876 : 477) ; Simmonds frequently confesses his frustration not to "expand on the subject matter" by fear to "weary the reader with too ponderous a volume" (ibid : 477)[4]. Interestingly, the perspective recorded by Simmonds and others is shared by famous economists such as Karl Marx and Alfred Marshall ; in the third volume of *the Capital*, Marx pointed out that with the advance "of capitalist production the utilization of the excrements of production is extended" and commented that "so-called waste plays an important role in almost every industry" (Marx, 1909/1894, Volume III, Part I, Chapter 5, non paginated) ; Alfred Marshall (1920 : Book IV, Chapter XI, non paginated) made similar observations in his *Principles of Economics*. The last quotation shall accrue to the American journalist Frederick Talbot who stresses that relating "all the fortunes which have been amassed from the commercialization of what was once rejected and valueless would require a volume. Yet it is a story of fascinating romance and one difficult to parallel in the whole realm of human activity » (1920 : 17-18). According to Simmonds, Britons were the first to develop by-products "on an extensive scale", their example being rapidly emulated in Continental Europe, USA, Australia and even South America.

Second, it is sometimes stressed that most by-products developed in the 19th century were derived from livestock wastes (see Clapp, 1994) ; case evidences show that there are no economic or technological reasons to believe that non-living organisms played a lesser role than living organisms as raw materials having yielded by-products. Rapid progress of scientific and technological knowledge made possible the full use of most residuals in

[3] The thirteen-page index of his third edition demonstrates the breadth of coverage. Among hundreds of case, let us quote « albumen from fish spawn », « asparagus stems for paper », « sulphur from coal gas » and so on.

[4] It must be stressed that Simmonds's attention paid to by-product development far exceeds the publication of his main volume (see Desrochers, 2009a for a review of his works).

iron and chemical industry, in particular.

Finally, let us note that following the example of any publication, works mentioned in table 1 are part of a dynamic set up reinforcing the "business as usual" pattern of by-products development. Journal articles, conferences, exhibits and other media drawn from this body of knowledge helped out to make it popular and to turn it into common knowledge (see Desrochers, 2009a).

Far from being exclusively descriptive, authors having dealt with by-products development tried to figure out the bottom line of the pattern that their works contributed to record ; as we will see, they widely share conclusions more sympathetic to market-oriented behaviors than what is usually postulated in current mainstream SD and environmental economics. Nevertheless and unlike a commonplace static and narrow (mis)conception of market-oriented behaviors, the latter are embedded in a dynamic set of values, beliefs and expectations helping to understand the rationale of human action. In this respect, it seems likely that creating "wealth from waste" was well ingrained in Victorian minds. For instance, in the preface to a 1928 survey of by-product development authored by the chemical engineer John B. C. Kershaw, a past president of the Federation of British Industries, Max Muspratt (1872-1934), observed that in the days of his childhood, "waste not, want not" was a lesson inculcated to young people. This cultural proclivity for parsimony somehow echoes the search for "sustainability" so widely praised one century later ; one should notice whereas parsimony leads on minimizing losses of value, it was obviously held as inherent to the market process unlike what is commonly stressed in the current literature (see section 1).

2-2. The bottom-line of the 19th century recycling pattern : profit, property rights and industrial symbiosis :

Interestingly, Victorian/European specialists of by-products development identified institutional and technological requirements at the root of the pattern they documented : spur of competition, property rights (and regulations pertaining to them), industrial symbiosis :

Search for profit under competitive pressures

Most writers that this work refers to emphasized the role of competitive pressures in triggering entrepreneurial efforts that eventually resulted in win–win outcomes (*i.e* the transformation of a loss –wastes- into a gain –by-products). For instance, Simmonds argued that, as competition became sharper, manufacturers had to look more closely to any item that might make the slightest difference between profit and loss (1876 : 205). In the same vein, Alexander Clemen, the leading economic expert of the US meatpacking industry of his era credited the fear of being overwhelmed by competitors in the same or other industrial sectors as the main force having spurred by-product development. Modern conditions, he argued, made it "almost impossible materially to cut production and distribution of expense for the majority of commodities". In this context, "one of the most important opportunities for gaining competitive advantage, or even for enabling an

industry or individual business to maintain its position in this new competition", was to reduce manufacturing expenses "by creating new credits for products previously unmarketable" (1927: vii). Quotations of this kind could here be multiplied.

Unless positing that some residuals are wasteful by their inexorable nature, there is nothing outstanding in such a statement, which refers to a dynamic market process. For instance, Karl Marx observed like many other analysts that reworked wastes "reduce the cost of the raw material to the extent that they are saleable. For a normal loss is always calculated as a part of the cost of raw material, namely the quantity ordinarily wasted in its consumption", waste utilizing ultimately increases "the rate of profit" (1909/1894 : 96). Indeed, Marx viewed industrial waste recovery as "the second great branch of economy in the conditions of production" (1909/1894 : 95), after production efficiencies arising from economies of scale.

It is not to say that Victorian/European denied the severity of environmental problems created by profit-seeking businesses in various locations. Cases of coal tar or slag skimmed over this paper suffice to show that the process leading on turning a waste into a by-product is gradual and even uncertain ; the simple fact to state that industry made headway in dealing with waste underlies that the starting point of such a trend was undoubtedly problematic. But instead of supporting that the trade-off between productive activities and the environment should be reconsidered a discretionary way, Simmonds and other authors pointed out that the race with profit led on win-win practices through creative problem-solving.

Legal pressure of property rights and other regulations

Although it has been stated that Victorian England was less prone to regulation than the Western countries are currently, it is obviously not to say that businesses dis not have to fear threats of legal action on the other hand their nuisances. Common and civil law provided the foundation for the resolution of disputes between industrialists and individuals harmed by their activities when these last were causing trespass (any entry on the property), nuisance (intangible invasions such as odors and noises) or violation of riparian rights (altering the quality or quantity of the natural flow of water beside or through someone's property). While authors like Playfair and Simmonds tended to deem that spontaneous market-driven incentives were more influential than external pressures, they did allude to the consequences of actual and potential legal actions on incentives to recycling.

Other writers paid more attention to this issue. Kershaw observed that the treatment of industrial wastes was often dictated by the necessity of "converting into an innocuous form some waste material, either solid, liquid, or gaseous, which, in its untreated state, is objectionable to the eyes or nose, or is detrimental to the health of the community" (1928 : 2). A few decades earlier, Freycinet's work reached similar conclusions. In sum and somewhat surprisingly in light of current theoretical debates, a number of writers at the time observed that private property rights and environmental regulations sometimes triggered creative thoughts among manufacturers which, in turn, eventually resulted in

the creation of profitable by-products from industrial residuals (see Desrochers, 2008). In doing so, they anticipated by more than a century the so-called 'Porter hypothesis', according to which well-designed regulations can stimulate innovations that, by enhancing productivity and reducing waste, increase private and social benefits (Porter 1991).

Industrial and technological conditions

While competitive pressures and, to a lesser extent, the need to internalize externalities played the key roles in the widespread development of by-products, this process was further facilitated by some characteristics inherent to most industrial residuals. First, their value was often initially low or nonexistent, while their disposal costs were sometimes significant. Secondly, unlike domestic waste, industrial residuals were uniform in nature and typically available in large quantities. Lastly, they were often produced in industrialized regions, thus reducing transportation costs. In this context, several manufacturers and their chemists followed a few logical steps described as follows by the French engineer Paul Razous (1905). Residuals were first thoroughly analyzed and broken into their basic components. If any of these had significant value, it was isolated. If this was not the case, the composition of the residual was compared with the components of similar products such as fuels, fertilizers, animal food or building materials. Two scenarios were then possible. If the residual components were similar to those of a given commercial input, the residual could probably be used for the same purpose. If one or a few components were missing, it was often possible to add whatever was necessary to turn the residual into a suitable substitute.

It is not to say that efforts dedicated to recycling were always proving fruitful as authors such as Koller and Kershaw point it out. But the risk attached to this long-odd/high-payoff strategy could be run whenever residuals were available in large quantities and industry organized in order to foster "loop-closing" processes[5] ; discussions regarding industrial conditions favorable for waste recycling do surprisingly anticipate issues raised by transaction cost economics (Williamson, 1985) some authors emphasizing that possibilities for effectively using wastes were generally greater in large plants (Babbage) while others pointed out interfirm arrangements akin to "clustering" and drawing on "industrial symbiosis[6]" between various proprietors (Simmonds, Clemen[7]).

[5] « Loop closing » is at the core of the « industrial ecology » metaphor that interestingly and even surprisingly, Playfair anticipated by stating in his major essay that the "economy of the chemistry of art is only in imitation of what we observe in the chemistry of nature" (1852 : 165-166). In later publications, commenting a quotation according to which "dirt is merely matter in the wrong place", he suggested that "as science advances, it sweeps up dirt from the wrong place and deposits it in the right place" (see Desrochers, 2009a : 718). In the current literature, ''loop closing'' refers to linkages whereby the waste products of one line of work become the valuable input of another (Ayres and Ayres 2002).

[6] "Industrial symbiosis is a concept used to describe geographically proximate interfirm relationships involving the exchange of residual materials, water, and energy" (Desrochers et Leppälä, 2010 : 338).

[7] Clemen's case study of the Chicago meat packing district is potentially insightful for transaction cost economics. It seems that the meat packers first outsourced part of their by-product development before progressively taking over the process within integrated bodies (see Desrochers and Leppälä, 2010)

While not theoretically designed in the light of current concepts, this body of analysis refers to a gradual and entrepreneurial conception of the market challenging the normative outreach of mainstream SD and environmental economics. Viewing the market as a system of coordinated human actions aiming at saving (and fostering) resources echoes the so-called "economic Austrian theory" from which interesting insights –and avenues of research addressed to sustainable development- may be derived.

3. A discussion : devising the market through other lens than narrow neoclassical ones :

The arguable « spontaneous » propensity of 19th century entrepreneurs to turn their costly residuals into valuable by-products lead on stimulating insights challenging some premises of mainstream environmental economics. We shall first challenge the concept of "market failure" nurturing one of the major tenets of mainstream economics. We will then turn our attention to the interplay between "profit seeking actors" and "environment" such as devised by "Austrian" theory. We will finally sketch some avenues of research likely to reverse the widespread anti-market prejudice encountered in the SD literature.

3-1. What is a "market failure" about ?

Stated in a nutshell, the assumption that a "market failure" leads companies on externalizing environmental costs « is steeped in standard neoclassical theories of efficiency and Pigouvian welfare economics » (Cordato, 2004 : 3). In light of the insights brought about the bibliographic material introduced in section 2, it is not anecdotic to recall that neoclassical economics devise the market as an "instrument" of price fixing purportedly failing to fulfill its duty when not reaching a "perfect" general equilibrium bringing each commodity's price at its optimal level (the so-called "state of nirvana" coined by Demsetz, 1969). It is to say that "imperfections" such as so-called externalities, public goods or asymmetrical information give birth to "market failures" precluding markets to convey economic information in a perfect manner ; when such market failures occur, institutional correction is purportedly needed –for instance, regulations- which liability obviously accrues to public authorities. Here stems the general statement from according to which regulation (even ethics) are needed in order to induce companies (*i.e* their managers) to adopt eco-friendly behaviors which, in turn, may become beneficial with the latter (see the Porter hypothesis, *op.cit*.).

Thus, neoclassical economics assume that full costs of productive activities should instantaneously be reflected in prices, without any room for gradual adjustment between conflicting individual concerns at stake regarding pollution. That is the reason why "externalized costs" are readily called "social" ; yet, "the concept of social costs, as typically invoked, completely disembodies and impersonalizes costs. Social costs exist outside of and apart from individual choosers » (Cordato, 2004 : 6). Put differently, « social costs » are posited « ex cathedra » by the analyst invoking them, albeit the latter cannot value it insofar as there is no valuation of "costs" aside from the one originating in the market system. In that sense and insofar as one keeps on reasoning in the framework of neoclassical economics, any "ex cathedra" correction of market failures should prove

inconsistent[8].

In a practical way, neoclassical regulations eventually aim at "repairing the tool" that the market is supposed to be ; in order to do so, "regulators" must approximate the value of social costs and make as to turn them to the sender (by means of taxes, for instance). Purpose of such regulations is henceforth to work towards a "first best" economic situation in order to enhance the efficiency of the market system. Although the consequences (and possible backups) of such regulations cannot be discussed in detail (for a critical discussion, see Desrochers, 2002), their overall design (and purpose) merits a comment in light of the insight brought about our historical material : regulations often focus on "end-of-pipe" technologies devoted to waste elimination (thus, letting no room for gradual reuse) ; one may identify the print of neoclassical economics in such a lawful design, which postulates a substantial (and static) distinction between a useful material and a waste (Swift, 1998). In a nutshell, "command-and-control" regulations somehow underpin the vision of "Mother Earth" as a stakeholder calling for immediate protection[9] instead of viewing pollution as a problem of neighborhood arousing incentives to turn not only the worthless but the harmful into the worthy.

3-2. Designing the interplay between the market and the environment through the lens of Austrian Economics :

According to Austrian theorists[10], "the market is not the impersonal buying and selling of goods and resources by independent contractors. The market is a system of private ownership rights which guides and constrains the actions people take to improve their situation" (Matthews, 1998 : 44). For such a purely individualistic conception of the market, (a) costs are strictly subjective, (b) efficiency refers only to "intra- and interpersonal plan formulation and execution" (Cordato, 2004 : 7) and (c) the market aims at resolving interpersonal conflicts for scarce resources on the basis of an efficient system of individual property rights. It ensues that, regarding the perspective on pollution, the Austrian outlook « shifts (…) from one of "market failure" where the free market is seen as failing to generate an efficient outcome, to legal failure where the market process is prevented from proceeding efficiently because the necessary institutional framework, clearly defined and enforced property rights, is not in place » (Cordato, 2004 : 10). Envisioning « pollution » by the yardstick of individual property rights leads on dividing environmental stakes into cases when rights are defined but ill-enforced (typically, conflicts of neighborhood) and cases when rights are simply non existent ("commons").

[8] By contrast, it would not be internally inconsistent to advocate that the market economy must be superseded by an overall « command and control » system of regulation which would make little and even no stake of any reference to interpersonal utility.

[9] See Stead and Stead (2000) as an illustration of this line of reasoning.

[10] Carl Menger's seminal work (1981/1871) is considered as the starting point of what has been denoted "Austrian economics". In the 20th century, most Austrian theorists refer to Ludwig Von Mises (1949) as being the leading figure of this school of thought (for more detail, see the web site of the Ludwig Von Mises Institute, http://mises.org/)

The prominence of the rule of law

The Austrian theoretical framework is a good candidate with the comprehension of the spontaneous propensity of entrepreneurs to reuse their wastes, throughout the 19th century. It is indeed often believed that "laissez faire" policy is characterized by a lack of regulatory constraints on industrial polluters. What is forgotten, however, is that traditional institutions that served as vital pillars for any robust market economy included property rights and the rule of law. These latter factors served as a powerful means of protecting property owners from environmental degradation because damaging someone else's property through polluting emissions was no more acceptable than vandalizing it. Although common or civil law regulations may be seen as part of the overall concept of regulation which, according to the Porter hypothesis, is a necessary condition in order to spur win-win innovations, it differs from "command-and-control" current environmental regulations. In a nutshell, civil law (henceforth, law) refers to rules aiming at making coordination of individual plans easier (or even possible) while statutory law (*i.e* legislation) aims at achieving political plans (for a broad distinction between "law" and "legislation", see Hayek, 1973). Yet, there is no conceivable market without any rule of law underlying it ; in this respect, one must not make a confusion between politically designed regulations targeting environmental benefits and the rule of law whose environmental impact is mediated by induced catallactic behaviors[11].

For example, along with statements made by Playfair and Simmonds, in countries operating under the British of legal tradition (*i.e* common law precedents), nuisance applications were quite comprehensive and covered, among other issues, public health (e.g. keeping of diseased animals), public safety (e.g. storage of explosives), public discomfort (e.g. dust, smoke, vibration) and public convenience (e.g. road obstruction). While this liability system mandated no specific conduct, remedies included compensation for past injuries, injunctions (an order by the court requiring the cessation of offensive activity or specifying corrective action), or compensation from expected future harm should the court allow the polluter to continue his actions. In some cases, remedies could also include abatement of the nuisance by self-help (Prosser 1966). Individuals could take legal actions against nuisances and seek either or both monetary damages or injunctions. According to most legal scholars, the threshold of proof was quite lenient as the plaintiff needed only to show that he or she had suffered physical or economic harms and such nuisance needed not be injurious to health. From the early decades of the nineteenth century onwards, however, British and American judges increasingly sought to balance the benefits of economic growth against the health and comfort of the public, and litigation based on the violation of private property rights slowly lost their effectiveness (Brenner, 1974).

By comparison of the powerful legal infrastructure provided by the common (or civil) law, some authors charged statutory law to be exceedingly permissive since it tended to nullify the deterrent properties of private property rights (Brubaker 1995; Meiners and Morriss 2000). In light of such a remark and while this issue remains outside the boundaries of this article, one could wonder if recent regulations did not shift the

[11] Austrian economics readily use the word « catallactic » instead of « economic ».

traditional recovery focus of industry executives and workers toward regulatory compliance laid on the aforementioned "arbitrary distinction" between a waste and a useful material (Desrochers, 2002 ; Meiners et Yandle, 1999).

The prominence of entrepreneurial behaviors

According to the authors which the core of our argument is drawn from, whether it is spurred by legal constraints or more spontaneously competition-driven, entrepreneurship plays a crucial role in the pattern that this paper focuses on. Indeed, as scientist Jesse Ausubel puts it: "pollution and waste usually indicate inefficiency. In an economy of competing companies, inefficiency is for losers. So, over the long run, successful companies are going to be green and clean" (1998 : 39).

This vision of the market as a dynamic system of competitive pressures bringing about change in the methods of production echoes the Austrian conception of entrepreneurship. According to one of its major theorists, once considered that information about prices is imperfect, profit opportunities exist which are never common knowledge ; henceforth, entrepreneurship may be defined as "alertness" to unnoticed price opportunities that some individuals will exploit by buying (selling) any commodity lower (higher) than the current price ; by doing so, entrepreneurs are endogenous change drivers in the market economy (Kirzner, 1973).

Nineteenth century's industrials may actually be devised as "super entrepreneurs" having sold for considerable value materials which were nothing but a matter of cost. However, one should keep in mind that such a Kirznerian arbitrage was made possible only through a long-odd process of research and innovation bringing about some risk bearing. Devising entrepreneurs as arbitragists –*i.e* somewhat traders- should not lead to lose sight that entrepreneurial operations always run on time and draw on a risky by nature roundabout process (for a discussion about "Austrian" entrepreneurship, see Klein, 1999). One may mundanely see 19th century's industrials as people having tried to benefit the best from economic and technological information at their disposal in order to improve their well-being. Since "knowledge" is the key element of the market process – property rights making up the foundation of the market as an institution- it is not surprising that "loop-closing" is all the more to be implemented that it benefits from day-to-day communications between industrials located in about the same place (see Desrochers and Leppälä, 2010)[12].

3-3. Conclusive reflection advocating counter-intuitive avenues of research :

At this point of our argument, it may be supported that (i) market-oriented economic behaviors are arguably more eco-friendly than what is usually thought and (b) search for profit (*i.e* "greed") may be sufficient to arouse conducts which indirectly benefit to the environment (albeit the triggering effect of statutory regulations should obviously not be brushed aside).

[12] In light of this last remark, it may be that the refocusing of many firms on their core competencies in the last two decades has reopened the doors to external symbiotic relationship.

Interestingly, while such a statement leaves room for discussion as for the Porter hypothesis, it does little case of any conceptual added-value recognized to ethical managerial behaviors such as those which are emphasized by CSR. In short, hence profit-motive and market competition may prove being eco-friendly behavioral drivers, why would managers need any alternative set of values in order to run companies an "ethical" way (if not for serving such or such vested interest) ?

The aforementioned question is stated a crude and provocative way ; discussing about any fruitful insight or flaw of the CSR doctrines is obviously outside the boundaries of this paper. Nevertheless, let us assume that most matters of fact stressed by the mainstream SD literature are actually relevant, namely our economic system leads on depressing ecosystems, depleting non renewable natural resources and in a whole, wrecking our natural environment. By deduction from our work, the following question would arise : what if 20th century's market economies were less "profit-oriented" than their "ancestor" ?

Two arguments could make up a starting point for such an heterodox avenue of research :

Firstly, it is interesting to point out that in the wake of Berle and Means seminal work (1932) about separation between ownership and control in US corporations, famous economists endorsed that from the beginning of the 20th century up to the age of "globalization" (approximately), power in major American companies had shifted from owners to professional managers (see Galbraith, 1967) this advent of managerial firms having possibly led "profit maximization" to be superseded by "sales maximization" in the range of managers' objectives (Baumol, 1959). It is plausible –and perfectly in line with our argument- that the alleged managerial omnipotence that one would infer from such an evolution entailed an overconsumption of resources (in particular natural) which is by nature wasteful (*i.e* harmful to the environment). Though highly conjectural, such an avenue of research may be supported by some overall remarks.

Let us first note that is would be pointless to charge "big managerial firms" for "ecological inefficiency" inasmuch as many among the authors nurturing our argument have stressed that big size was a facilitating and arguably necessary condition for recycling wastes. On another end, it would likely be simplistic to set a crude historical distinction between the age of the market (that would be characteristic of the 19th century) and the age of the management (that would be characteristic of the 20th century). Furthermore, albeit new institutional economics readily tends to draw a boundary between transactions ruled by the market and operations ran within the organization (see Coase, 1937), such a distinction is somehow hazy. After all, isn't the choice of commercial partners a managerial task ? Conversely, aren't managerial skills sold and bought through a market ? (see Matthews, 1998).

An insightful critical reappraisal of issues at stake regarding the separation between ownership and control may once again stem from Austrian economics : Padilla and Kreptul argue that "separation of ownership and control means that owners have

delegated part of their control and use rights to the managers but ultimately keep the most important residual right to take away the delegated control and use rights from the managers if they are dissatisfied with how the firm is managed. On the other hand, managerial omnipotence is when owners have either : virtually lost their residual control rights ; cannot exercise their residual control right because the costs of doing so outweigh the benefits » (2004 : 4-5). In sum and as to make the distinction between "market" and "organization" relevant, firms headed by omnipotent managers and firms directed by managers under control of owners should not be mixed up. Yet « a familiar liability of investor-owned firms (…) is that investors are frequently in a poor position to discipline management. In the typical publicly traded US business corporation, no individual shareholder possesses a block of stock sufficiently large to provide a meaningful degree of control. This is true not only for individual shareholders, but even for groups of shareholders that might wish to act collectively in influencing corporate activity. (…). As a result, the managers of many large corporations have long been essentially self-appointing and self-policing, free of direct accountability to their company's owners » (Hansmann, 1996 : 57).

Once admitted that the Berle-Means corporation primarily results from this fragmented ownership, it is noteworthy to stress that the latter widely lies in the accumulation of state and federal legislation since the end of the 19th century (Roe, 1994) having entailed "legal restrictions on financial institutions, insider trading regulation, antitrust regulation, federal and state anti-takeover restrictions, state corporate law of fiduciary duty, and contract and labor legislation » (Padilla and Kreptul, 2004 : 12).

In sum, it is not irrelevant (although highly conjectural at this stage) to argue that throughout the 20th century, a growing body of regulations progressively lessened the efficiency of ownership control on firms (in the US but also, quite a different way, in Europe, see Klein, 1999). Yet, keeping up with our line of argument, weakened property rights may have induced harmful fallouts on the environment. Such an avenue of research would be challenging for the core of CSR inasmuch as it runs counter some widespread recommendations according to which managers should balance stakeholder and shareholder interests in order to relieve the firm from "short-term" financial pressures. In contrast, our argument would call for more proprietary control (*i.e* less discretionary management) on the running or companies.

Secondly and keeping on acknowledging that productive activities may actually have harmed "Planet Earth" an hazardous way in the 20th century, it is outstanding to notice that, to the best of our knowledge, works are seldom that took an interest in the ecological fallouts of stimulative economic policies consisting of lowered interest rates and fiscal deficits in order to leverage the consumption of goods (*i.e* resources). Although Austrian theorists have paid peculiar attention to boom and bust economic cycles possibly caused by financial and fiscal stimulus (see Cwit, 2008 for instance) little is said about its interplay with "sustainable development" issues.

Conclusion

Despite widespread beliefs to the contrary among sustainable development theorists, much evidence suggests that competition, the price system, and legal constraints based on property rights and/or specific legislation enactments historically led to significant reduction in the amounts of waste released into the environment by various industries operating all along the 19th century in Western Europe.

Assuming that the analysis presented in this essay is by and large correct, why is it so much at odds with current historical analysis? One can think of a few reasons. A first is that, in some cases, pollution problems took years and even decades to be solved profitably. While they might have been considered an acceptable (perhaps mistakenly) price to pay in a growing economy, vivid descriptions of burning rivers or cities covered with smoke and soot certainly do not help convey the impression that progress was being made in this respect. Perhaps just as significant is the fact that doomsday visions of the environment have become dominant over the last four decades. This worldview might explain the widespread belief among academics working in disciplines ranging from engineering to economics that past industrial development was characterized by a linear process of extraction, production, use, and disposal[13].

This paper provides some evidence that industries covering a wide array of activities made a fruitful use of their wastes throughout the 19th century, especially in Victorian Great Britain. It contents sufficient insights to challenge the mainstream visions of the interplay between ecology and economy both in the popular and academic literature. It also suggests that narrow-designed conceptions of the market as a mere "machinery of prices" do not render justice to its procedural nature. Nevertheless, the limitations of this work are inherent to case studies. As already stated, it is irrelevant to derive any generalization from a collection of documents, even numerous. Furthermore, knowing if we should credit profit-seeking incentives or triggering regulations with "end-of-pipe" ecological virtues remains opened to discussion. At last and recalling that a free market is not a consciously controlled device dedicated to any political end, anyone can always reckon that its course is detrimental (or not beneficial enough) to such or such kind of "social needs".

Our work does not primarily intend to challenge value-based visions of the environmental cause insofar as such political visions tend to blame markets for not attaining objectives they have never been designed for. This paper basically aims at challenging the concept of "market failure" at the core of "sustainable development" tenets by arguing that, although not perfect, the invisible hand contains qualities of parsimony and self-regulation which may prove being, somewhat unexpectedly, eco-friendly over the long run.

[13] One could even point out there is something tautologically inconsistent in stating that "industrial revolution damaged the natural environment" at least when recalling that no animal specie could thrive in such a depressed environmental context. Yet, the industrial revolution set along with a demographic revolution having dramatically increased the European population.

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